

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554**

In the Matter of)	
)	
Use of Spectrum Bands Above 24 GHz For)	GN Docket No. 14-177
Mobile Radio Services)	
)	
Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95,)	WT Docket No. 10-112
and 101 To Establish Uniform License Renewal)	
Discontinuance of Operation, and Geographic)	
Partitioning and Spectrum Disaggregation Rules)	
and Policies for Certain Wireless Radio Services)	
)	

COMMENTS OF STARRY, INC.

*Virginia Lam Abrams
Senior Vice President, Communications
& Government Relations*

*Brian Regan
Senior Director – Legal, Policy, & Strategy*

Starry, Inc.
38 Chauncy Street, 2nd Floor
Boston, Massachusetts 02111

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SUMMARY

The 37-37.6 GHz band represents a critical opportunity for the Commission to enhance its 5G efforts by making a small piece of useful lower-band millimeter wave spectrum available for a wide variety of users and use cases with low barriers to entry. As the Commission continues to provide greater certainty and predictability regarding access to this spectrum, innovators, new entrants, incumbents, industrial users, and others will begin investing in the Band, adding significantly to the United States' 5G effort.

Starry, for instance, has raised over \$160 million in venture financing to provide last mile broadband to consumers across the country. And as a result of the Commission's decision in the *Third Frontiers R&O and FNPRM* reaffirming the status of the Band, Starry was able to close a significant round of financing from world class investors.

But there is more work to do. Through the *Third Frontiers R&O and FNPRM*, the Commission lays the cornerstone for a licensing and sharing framework for the Band. We strongly encourage the Commission to work with all stakeholders to expeditiously complete the rules for this band in the near-term.

In these comments, we recommend a two-phased sharing and coordination framework, starting with relatively simple geographic and frequency sharing in the near-term, and suggest adding dynamic elements like beaconing/sensing and the use of dynamic databases over time. We suggest geographic protection zones based on relatively simple propagation analysis that distinguishes between line-of-sight and non-line-of-sight deployments. The protection zone would be drawn using the propagation analysis along the requested azimuth using the characteristics of the specific base station, and would be a normalized arc reflecting the furthest point in the modeled propagation for the given base station. Customer premises equipment would be authorized to operate within the protection zone without additional licensing or registration, assuming a relatively modest beamwidth to ensure directionality and minimize interference. We suggest adding a frequency domain to provide access in areas of congestion by allowing a coordinator to reduce a licensee using 600 megahertz down to a maximum of 400 megahertz. We also suggest a small update to the out-of-band emission rules to better protect collocated base stations.

To facilitate near term use and disincentivize bad actors, we suggest rules that would establish a window for filing initial applications once licensing commences within which all

applications will be treated as being file concurrently, impose reasonable but aggressive construction deadlines (90 or 120 days for base stations), support the Commission's proposals preventing licensees or registrants that do not construct from seeking a license or registration for the same area, and suggest an enhancement that would disqualify applicants from applying for a base station if they are a repeat offender.

In order to improve coordination timelines, we suggest that if Part 101 coordination is used, the notice and response timeline be reduced to only 10 business days. We also suggest that applicants should be permitted to operate on a temporary basis while their applications are pending.

Finally, we suggest that the Commission work collaboratively with NTIA and federal agencies to enhanced federal/non-federal sharing through predictable mechanisms in the near- and long-term. We suggest that federal users, in particular the Department of Defense, could increase the number of protected military bases outside of population centers, and could otherwise coordinate into the band like a non-federal user through NTIA. This band is an opportunity to further unlock spectrum by continuing to evolve federal and non-federal sharing, and we are committed to working with the Commission, NTIA, and DoD to create a framework that enables both federal and non-federal users to reap the benefit of their co-primary allocations.

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COMMENTS OF STARRY, INC.

Starry, Inc. (Starry)¹ submits these comments in strong support of the Federal Communications Commission’s (FCC or Commission) continued commitment to making the 37-37.6 GHz band (Lower 37 GHz Band or Band) available for coordinated licensed shared access, and to offer our suggestions on the optimal licensing and coordination mechanisms. The Commission’s decision in the *Frontiers Third R&O and FNPRM*² reaffirming that the Lower 37 GHz Band will be available on a licensed shared basis is a boon to innovators, entrepreneurs, and competitors who now have clarity in their ability to access this useful millimeter wave (mmW) spectrum.

With a clear decision on the future of the Band, we are confident that the Commission, the industry, the National Telecommunications and Information Administration (NTIA), and federal agencies can work together to craft an effective sharing and coordination mechanism, to

¹ Starry, Inc., is a Boston- and New York-based technology company that is utilizing millimeter waves to re-imagine last-mile broadband access as an alternative to fixed wireline broadband. Starry is currently deploying its proprietary fixed 5G wireless technology in the Boston, Washington, DC, and Los Angeles areas, with plans to expand to our presence to additional U.S. cities in 2018.

² *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services; Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services*, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, GN Docket No. 14-177, WT Docket No. 10-112 at ¶¶ 37-40 (rel. June 8, 2018) (*Frontiers Third R&O and FNPRM*).

the benefit of all Americans. Conceptually, we believe that the Commission should focus on achieving three goals for sharing in the Lower 37 GHz Band: 1) enabling near-term access to the spectrum through relatively simple coordination in order to stimulate continued investment in new technologies, services, and networks; 2) adopting robust requirements to incentivize the use of the spectrum and strongly penalize bad actors who intentionally foreclose the use of the Band by others; and 3) building a predictable coordination mechanism for federal and non-federal co-primary sharing in the near-term, while continuing to collaborate on enhancements.

Ultimately, this relatively small amount of spectrum can serve as a test bed for new and innovative mmW technologies, can enable near-term deployments to enhance residential fixed broadband competition, can immediately add backhaul capacity for fixed and mobile deployments, and can meet myriad industrial and Internet-of-Things use cases.³ We strongly encourage the Commission to engage in an open and collaborative process with all parties to craft the optimal licensing and coordination scheme, and to move forward with a Report and Order within one year of the above the *Frontiers Third R&O and FNPRM*.⁴

I. NEAR-TERM ACCESS TO LICENSED SHARED SPECTRUM WILL FACILITATE RAPID INNOVATION AND BROADBAND DEPLOYMENT

Starry's position as a world leader in new fixed mmW technologies and services is a direct result of the Commission's policies promoting innovation and competition in mmW spectrum.⁵ Starry has raised over \$160 million in venture financing because of the Commission's continued efforts to provide greater regulatory clarity and certainty regarding access to shared spectrum in the Lower 37 GHz Band. And most recently, as a direct result of the Commission's decision in the *Third Frontiers Report and Order*, Starry closed a C Round of financing raising \$100 million from world-class investors.⁶

³ See *id.* at ¶ 63.

⁴ If the rulemaking process runs for another two-year period, it will significantly impair new investment in this Band. As such, we encourage the Commission to consider ways to continue to incentivize use of the Band in the near-term through its Experimental Licensing process including potentially by incorporating sites that would otherwise comply with the licensing and technical rules into the coordination framework from the start.

⁵ Shared access in the 37 GHz band "will promote access by a wide variety of entities, support innovative uses of the band, and help ensure that spectrum is widely utilized." *Use of Spectrum Bands Above 24 GHz, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, 8059, ¶ 112 (2016) (*Frontiers First R&O and FNPRM*).

⁶ See U.S. Securities and Exchange Commission, Form D, Notice of Exempt Offering of Securities, Starry, Inc. (filed July 3, 2018). Starry employs over 300 full time staff in Boston, Los Angeles, New York, and Washington, D.C.

Starry was founded with the goal of improving last-mile broadband competition and connectivity across the country – a goal this Commission shares.⁷ Starry set out to achieve this goal by upending the traditional cost structure for fixed broadband through its own high-capacity fixed, point-to-multipoint wireless ecosystem. Starry’s technology and integration as both an equipment developer and network operator allows it to deploy gigabit-quality last mile connectivity at orders of magnitude below the cost of last mile wired networks.⁸ We do this by: 1) designing and building our own equipment, thereby eliminating vendor margins from our cost structure; 2) utilizing to the greatest extent possible existing radio technology (instead of attempting to create new baseband radios), and coupling these robust radios with our own frequency conversion and antenna front end technologies; and 3) using mmW spectrum, which provides high capacity relative to lower bands. This strategy has driven significant U.S.-based innovation in new fixed mmW technologies, and has helped create a business that can support new competition and expand broadband access to *millions* of households across the country.⁹

Starry’s financing supports its continued development of its own pre-standard 5G fixed wireless equipment and its market testing in cities across the country. Starry is now manufacturing its second-generation production equipment, incorporating significant learnings from the past two and a half years building equipment and operating mmW networks in real world deployments. We are engineering, designing, and manufacturing three models of base stations, three varieties of customer premises equipment, two different in-home access points, and design and operate our own bespoke cloud control plane to manage our network.

We have spent millions of dollars to design, develop, and manufacture this equipment, and millions more deploying our technology and service throughout the Boston, Los Angeles, and Washington, D.C. areas.¹⁰ Ultimately, our goal is to create a high capacity access network

⁷ See Statement of Chairman Ajit Pai, United States Senate Committee on Commerce, Science and Transportation, “Oversight of the Federal Communications Commission” (Aug. 16, 2018).

⁸ See Starry, Inc., *FCC Progress Report II*, Call Sign W12XEB, at 6 (filed Dec. 8, 2017) (Starry Second Progress Report), <https://apps.fcc.gov/els/GetAtt.html?id=202100&x=>; see also Eillie Anzilotti, *This Startup is Trying to Beam Cheap Internet Into Low-income Communities*, FAST COMPANY, Sept. 7, 2018, <https://www.fastcompany.com/90232340/starry-wants-to-close-the-internet-gap-in-public-housing>.

⁹ Since launching commercial testing at scale less than 12 months ago, Starry is already passing over 350,000 households with its service and is experiencing over 25% month over month subscriber growth. See Mike Dano, *Starry Expands Deployment Plans, Reaches 350k Homes in Boston*, FIERCE WIRELESS, Aug. 13, 2018, <https://www.fiercewireless.com/wireless/starry-expands-deployment-plans-reaches-350-000-homes-boston>.

¹⁰ We expect to deploy an initial footprint in up to 16 additional U.S. cities this year. See *Starry Announces Launch of Starry Internet in Los Angeles and Washington, DC*, Press Release, Jan. 4, 2018, <https://dyajmw2sca9cs.cloudfront.net/press/pdf/04%20January%2018%20-%20Starry%20Announces%20Launch%20of%20LA%20and%20DC%20Press%20Release%20-%20FINAL.pdf>.

that can reduce the cost of capacity to any user, and to create a robust ecosystem of low-cost devices and technologies.

We are also testing low-cost and free products for underserved communities through our Starry Connect program.¹¹ Under Starry Connect, we will partner with building owners and other strategic partners to bring low-cost, high-quality broadband service to residents in affordable housing. As part of this effort, we recently launched a pilot program with the Boston Housing Authority (BHA) to provide free common area WiFi in a BHA building for its residents.¹² This network allows residents to freely access WiFi throughout all common spaces in the building. If the pilot is successful, we are committed to working with BHA to bring the service to other buildings and residents. We also very recently announced a new partnership with Related Companies to deploy low-cost Starry service to Related's portfolio of thousands of affordable housing units across the country.¹³ Over time, through these partnerships, Starry Connect will provide much-needed connectivity and competition to thousands of Americans who currently suffer from poor or no true broadband connectivity. All this innovation and investment flows directly from the Commission's decisions regarding shared access in the Lower 37 GHz Band.¹⁴

The Commission can further stimulate this significant U.S.-based innovation and investment by acting quickly to finalize the licensing and coordination rules for the Band, focusing on simple and implementable rules in the near-term, while continuing to iterate and enhance the framework over time.

II. THE COMMISSION CAN IMMEDIATELY ACTIVATE THE LOWER 37 GHZ BAND USING SIMPLE GEOGRAPHIC AND FREQUENCY COORDINATION NOW AND UPGRADING TO MORE DYNAMIC SHARING OVER TIME

Starry continues to believe in the power of technology to solve difficult policy problems, including optimizing spectrum sharing. We appreciate the Commission's thoughtful approach to

¹¹ See Starry Connect, <https://starry.com/starryconnect>; see also *Starry Launches Pilot Program with the Boston Housing Authority to Expand Affordable Internet Access in Boston's Public Housing Communities*, Press Release, Aug. 9, 2018 (BHA Program Announcement) [https://dyajmw2sca9cs.cloudfront.net/press/pdf/Starry%20Announces%20City%20of%20Boston%20BHA%20Pilot%20Program%20\(Aug%202018\).pdf](https://dyajmw2sca9cs.cloudfront.net/press/pdf/Starry%20Announces%20City%20of%20Boston%20BHA%20Pilot%20Program%20(Aug%202018).pdf).

¹² BHA Program Announcement.

¹³ *Starry Announces Strategic Partnership with Related Companies and Launch of Starry Internet in New York City*, Press Release, Sept. 7, 2018, <https://dyajmw2sca9cs.cloudfront.net/press/pdf/Starry%20Announces%20Strategic%20Partnership%20with%20Related%20Companies.pdf>.

¹⁴ And we note that Starry is not alone – the record demonstrates interest in this Band from wireless internet service providers and others. See *Wireless Internet Service Providers Association, Letter*, GN Docket No. 14-177 *et al.* (filed Nov. 2, 2017); *Dynamic Spectrum Alliance, Letter*, GN Docket No. 14-177 *et al.* (filed Nov. 9, 2017); *Comments of GeoLinks*, GN Docket 14-177 *et al.* (filed Feb. 22, 2018).

licensing in the Lower 37 GHz Band, and generally support its proposed approach. Below we offer suggestions to maximize the availability of spectrum in the Band in the short-term, to set a path to continue to enhance and iterate on the sharing framework over time, and to ensure licensees act in good faith and put the spectrum to use for the public benefit within reasonable but aggressive timelines.

At the outset, we note that because of the large variety of potential use cases in the Band, the coordination and licensing scheme can become very complicated, which we address below by offering simplifying suggestions.¹⁵ We agree that, fundamentally, coordination should be based on first-in-time rights, and that licensees or registrants should have an expectation of use and reasonable interference protection, but not of exclusion.¹⁶

Additionally, with respect to the distinction the Commission draws between registering sites with a coordinator or using Part 101 licensing rules¹⁷ – we did not necessarily intend them to be mutually exclusive in our 2017 proposal for this Band.¹⁸ Whether a base station is licensed as a Base Station License, registered under a Site Cluster License, or coordinated and authorized through some other means, we agree that each new site would need to be coordinated against existing sites for which the new site has the potential to cause harmful interference.

We also observe that the three different licensing schemes could logically be collapsed into two – Base Station Licensing and Site Cluster Licensing. Practically, a Point-to-Point License in this Band is effectively a Base Station License with a very narrow sector, and as we suggest below, the Commission should allow applicants to request a less than 360-degree sector as necessary. Coordinating an additional Base Station License would be much simpler than trying to determine the appropriate interference threshold along a point-to-point link, especially given the fact that the coordinator will not have any information about the customer premises equipment (CPE) associated with the licensed base station (with both the base station and CPE providing sources of potential interference to a point-to-point link). There are also many dedicated point-to-point bands in mmW spectrum if the Base Station Licensing scheme does not

¹⁵ The Commission envisions at least four types of deployments: point-to-point, fixed wireless broadband, mobile systems, and IoT-type systems. *See Frontiers Third R&O and FNPRM* at ¶ 63.

¹⁶ *Id.* at ¶ 65.

¹⁷ *Id.* at ¶ 64.

¹⁸ *Starry, Inc., Letter*, GN Docket No. 14-177 *et al.* (filed July 13, 2018) (Starry Sharing Framework Proposal).

meet a user's needs.¹⁹ To the extent that the Commission maintains a discrete Point-to-Point license, we suggest that the enhanced sharing techniques we discuss below, including beaconing and dynamic time-based databases, should also apply to Point-to-Point Licenses.

Below we offer suggestions to maximize the utility of the Band in the short term, set a path to continue to enhance the framework over time, and to ensure licensees put the spectrum to use immediately while also penalizing bad actors.

A. Coordination Should Start Simply and Evolve Over Time

As discussed, there are significant benefits to activating the Lower 37 GHz Band in the near-term. We believe that, in time, the Commission, industry, and federal users will gain significant experience and understanding of the technology, use cases, deployment models, and interference environment. As this education progresses, the Commission can and should continue to iterate on the licensing and coordination mechanisms.

In the near-term, however, we strongly urge the Commission to adopt a relatively simple licensing and coordination framework to serve as the foundation for the Band. We do not know enough today about all the technologies that may be deployed, how they may be deployed, the services they may enable, and their interference tolerances in order to craft a modern and dynamic sharing regime.

Instead, we generally support the Commission's decision to model the coordination on a Part 101-like process as the initial baseline for coordination, with relatively simple but updated licensing and coordination rules. As a start, we believe the Commission can continue to promote innovation and investment in the Band in the near-term by relying on simple geographic and frequency coordination now, and adding additional elements and tools, like database-enabled sharing, and beaconing and sensing, to facilitate sharing on a more granular and intensive scale.

B. Base Station Coordination Should Rely on Realistic Geographic Protection Zones Based on a Simple Propagation Model

We approach coordination in the Band as a user and operator that wants to prioritize the availability of spectrum over our own protection. We believe that, initially, Base Station Licensing and registration should be based on geographic coordination that uses simplistic propagation modeling with few variables to define a protection zone within which a user's operation would be protected. We agree with the Commission that CPE may operate within a

¹⁹ See 47 C.F.R. § 101.101.

protection zone without having to be individually licensed or registered, provided that the CPE operates in connection with only those base stations that make up the related protection zone(s). We suggest the Commission adopt modifications to its proposal, as articulated below, which we believe will result in a simple and enforceable licensing and coordination process.

While we agree that establishing a static 1 kilometer zone is conceptually simpler, it would be difficult to implement in practice and will likely over protect base stations serving mobile users and under protect base stations serving fixed users. For example, a base station deployed above the clutter, operating at maximum power in a dry climate could radiate over 10 kilometers, while a base station in severe clutter in an urban environment in a city in the southeastern United State may only cover tens of meters. Therefore, we suggest the Commission establish protection zones using propagation analysis considering some basic characteristics of each base station, similar to our July 2017 proposal.²⁰ Specifically, we suggest that the Commission require each Base Station License applicant or registrant to specify the power, azimuth, height above average terrain, requested bandwidth, and antenna pattern for each requested license or registration.

We suggest that coordinators use a propagation model to define the protection zone for the base station, and that the propagation model accommodate a simple assumption regarding whether the site is in a line of sight (LOS) or non-line of sight (NLOS) environment, and run an optimized propagation analysis for each as appropriate. We suggest that 50 feet serve as the cutoff between LOS and NLOS deployment and analysis, using recently established height limits for streamlined treatment of small cells.²¹ This assumes that mobile deployments will likely be in the clutter in NLOS scenarios attached to utility poles or municipal furniture, and fixed deployments will be above clutter located on building rooftops and other tall structures.²²

Using the specific base station characteristics and the LOS or NLOS propagation model, the protection zone would be defined as the normalized cone that represents the point at which the base station transmission at the specified azimuth reaches a power level of -79 dBm/100 MHz as measured by a hypothetical interfered antenna with zero gain pointed in the direction of

²⁰ See Starry Sharing Framework Proposal at 4.

²¹ *Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment*, Second Report and Order, WT Docket No. 17-79, at ¶ 74 (rel. Mar. 30, 2018) (*2018 Wireless Facilities Second R&O*).

²² See Starry Second Progress Report at 10.

the base station.²³ Applying this analysis to a hypothetical site in a LOS deployment and using the NYUSIM model,²⁴ assuming a reasonable 60 dBm EIRP total power for LOS, the modeled protection distance would equal approximately 5 kilometers. Using the same analysis with the NLOS model generates a 175-meter protection distance. (See Appendix A for the detailed analysis). This approach clearly produces protection distances that more closely match the deployment scenarios and expected propagation (and therefore protection) of base stations in this Band. Given that a simple LOS propagation model can produce significant protection distances at high power in these bands – larger than may be necessary or efficient – we suggest a maximum distance of 3 kilometers for any Base Station License. Since deployments in this frequency range need to overcome attenuation due to precipitation, we suggest that active transmitter power control be used to increase EIRP only to a higher level up to the maximum permissible as necessary to abate weather conditions in order to meet the 3 kilometer maximum protection distance.

To further simplify the licensing and coordination process, we suggest the Commission allow licensees to apply for any size sector up to a 360-degree radius, under the assumption that an applicant will sometimes site multiple base stations with the same characteristics at the same location.²⁵ In such a case, the propagation analysis could be run across multiple points along the 360-degree sector, and the furthest distance at which the -79 dBm/100MHz level is met would form the point on which the radius of the cell is determined (see Appendix B for a simplified example of how this would be implemented).

Just like a static protection zone based upon a uniform distance, under this structure, a frequency coordinator would simply determine whether a protection zone drawn in this manner for a new site will intersect the protection zone of any other site.

We also suggest that under each Base Station License or registration, the licensee or registrant could register additional smaller or lower power base stations without any further

²³ In other words, the protection zone will be artificially ‘smooth’ using the furthest point based on this propagation analysis across the width of the azimuth. See the antenna plot in Appendix B.

²⁴ NYU Wireless, NYUSIM, <http://wireless.engineering.nyu.edu/nyusim/>. The NYUSIM “provides a complete statistical channel model and simulation code with an easy-to-use interface for generating realistic spatial and temporal wideband channel impulse responses.” NYSIM 5G Channel Simulator Now Available (July 13, 2016), <http://wireless.engineering.nyu.edu/nyusim-5g-channel-simulator-now-available/>. See also Theodore S. Rappaport, Shu Sun, and Mansoor Shafi, *5G Channel Model with Improved Accuracy and Efficiency in mmWave Bands*, IEEE FUTURE NETWORKS, Mar. 2017, <https://futurenetworks.ieee.org/tech-focus/march-2017/5g-channel-model>.

²⁵ See *Frontiers Third R&O and FNPRM* at ¶ 71.

coordination if the sites would not extend the protection zone in any direction. That is, a licensee or registrant should be able to manage its own self interference and densify its own network within the boundaries of the protection zone if it does not increase the size of the protection zone. As an example, in a LOS fixed deployment, because building height is not uniform, there are instances in which a single building that is taller than its surrounding neighbors blocks the signal, preventing the provider from serving those smaller buildings with the licensed or registered base stations. In that scenario, a licensee or registrant should be permitted to add another lower-power base station to act as a repeater to carry the signal to the effected buildings.

With respect to the CPE deployed within a base station protection zone, we suggest a small technical rule update to ensure that real-world deployments match the expectation that the CPE themselves will not cause harmful interference. Specifically, we suggest that the CPE must use a 35 degree or smaller solid angle beamwidth, and operate at an EIRP less than or equal to that of the associated base station. If a single CPE is transmitting multiple coherent beams, the sum should be limited to 35 degrees or less. And if a CPE is simultaneously transmitting multiple fully incoherent beams, each equivalent transmitted formed beam should be 35 degrees or less.

We specifically note that while this does not guarantee that the primary direction of the CPE generated interference is towards the interior of its own serving base station protection zone, it does ensure some amount directionality of the transmission, while also enabling NLOS operation using reflected beams.²⁶ Alternatively, the required CPE beamwidths can be further narrowed to 25 degrees, providing greater directionality. Establishing a beamwidth specification will help ensure that high gain LOS operating CPEs are directionally focused at their target base stations, and will limit the likelihood that they cause interfere to adjacent protection zones.

To further enhance this coordination scheme, specifically with respect to inter-boundary coordination, we urge the Commission to set the expectation that neighboring licensees may establish their own coordination criteria governing their mutual interactions at the boundary of their license areas. The geographic boundary just establishes a baseline of protection and permission, but licensees should be encouraged to work together to maximize their operations along shared borders.

²⁶ With respect to NLOS transmissions, predicted path loss as a result of attenuation from buildings, foliage, or other obstacles provides additional natural interference protection.

C. Frequency Coordination Will Facilitate Greater Usage in Areas of Congestion

In addition to coordinating new base station applications on a geographic basis, the Commission can further enhance coordination by adding a frequency dimension, which will create another layer of shared access in geographic areas in which there may be overlap between base station protection zones.

While we support the Commission's decision to use a 100 megahertz channelization and to allow any licensee to aggregate up to 600 megahertz in a given area,²⁷ that may unreasonably restrict the ability of a new entrant to access the Band, especially during the interim period where coordination is geographic-based. Therefore, in all or part of a geographic protection zone (*i.e.* part of a 360-degree sector), we suggest that the Commission allow the coordinator to reduce the channelization of a licensee using 600 megahertz down to a minimum of 400 megahertz. As a result, in any given geographic area there could be a maximum of six different licensees, and a minimum of two.

As the Commission considers moving towards 100 megahertz channelization as the uniform license block size,²⁸ we believe that being able to aggregate up to four channels even in areas of congestion will still provide sufficient bandwidth for effective high-bandwidth services. Starry, for instance, can provide a gigabit-quality service using two, 200 megahertz channels using current 802.11ac radios, and expects to double capacity when it upgrades to new 802.11ax based radios.²⁹

D. Small Modifications to the Technical Rules Will Further Enhance Coordination and Simplify Sharing

In order to further limit the interference potential between neighboring base station protection zones, we suggest that the Commission tighten the out of band emission requirement for base stations in the Lower 37 GHz Band. We do not believe that the current limit of -13 dBm/MHz adequately protects base stations collocated on the same infrastructure with non-intersecting zones extending from each.

Deployments in the Lower 37 GHz Band, particularly for LOS fixed services, should be able to share infrastructure with other deployments. For instance, in an urban environment where

²⁷ *Frontiers Third R&O and FNPRM* at ¶ 28.

²⁸ *See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, GN Docket No. 14-177, *Fourth Further Notice of Proposed Rulemaking*, at ¶ 9-13 (rel. Aug. 3, 2018).

²⁹ *See Starry Second Progress Report* at 5-6.

wireless facilities are predominately sited on building rooftops, users should not be precluded from deploying on a specific rooftop because of the potential interference from another Lower 37 GHz Band base station. With multiple providers' equipment collocated, the possible deleterious effect is caused by the impairment of adjacent channel and alternate channel users' receivers being desensitized by another user's transmitter due to spurious transmissions. Therefore, a reasonable adjacent channel protection ratio should be utilized to ensure collocated base stations are not materially impaired. We believe a reasonable limit will avoid the need for Lower 37 GHz base stations to use sophisticated receiver interference cancellation or customized mechanical or antenna work required to provide additional isolation. We note that Commission has for years required tighter out of band emission limits for site-base point-to-multipoint type systems.³⁰

Specifically, we suggest that the Commission tighten the out of band emission limit for adjacent channel emissions to -33 dBm/MHz, and for alternate channel emissions to -43 dBm/MHz. Assuming that an EIRP limited transmitter with a 30 dB gain array is driven by a +45 dBm conducted power over 100 megahertz, it produces +25 dBm/MHz of conducted power. Typical collocated transceivers may achieve only 60 to 80 dB of isolation, depending upon the collocated spatial clutter and objects within the near operation of the transmitters. This is especially true of highly reflective building top environments or building sides in urban canyons. Using 70 dB as a midpoint, then at the current -13 dBm/MHz limit the received interfering power is -83 dBm, which is approximately 30 dB above the noise floor. So, by placing two base stations in close proximity, as is common in shared installations, one transmitter significantly desensitizes the other's receiver.

However, with reasonable limits of -33 dBm/MHz for adjacent channel emissions and -43 dBm/MHz for alternate channel emissions, the Commission can significantly limit the impact of collocated base stations on each other.³¹ We note that even at these levels, the adjacent interferer is still materially above the noise floor, and we suggest the Commission encourage parties to coordinate with each other to further limit interference.

³⁰ See, e.g., 47 C.F.R. § 90.210.

³¹ We note that Land Mobile Radio is one of the only current services for which the technical rules address site-based point-to-multipoint systems, and use a similar metric to protect adjacent users. Section 90.209 establishes 60 or 65 dB as an adjacent channel protection ratio. See 47 C.F.R. § 90.209. Under our proposal with 45 dBm (approximately 30W conducted power) and -33dBm/MHz in a 100 megahertz channel, the adjacent channel protection ratio is 58 dB, which is consistent or slightly less restrictive than lower frequency typical cellular base stations.

Finally, we note that these issues can be largely eradicated with synchronized systems, and suggest the Commission consider – now or through further iteration on the sharing and coordination framework – a requirement that all Lower 37 GHz Band base stations maintain synchronization linked to GPS, regardless of access method used.

E. Sensing, Database-enabled Sharing, and Other Techniques Can Increase Utilization of the Band Over Time

We strongly believe that the Commission can and should continue to improve the licensing and coordination process over time. The Commission’s proposal and our suggestions herein are focused on solving the licensing and coordination in the near-term. However, technology continues to evolve in ways that make sharing far more dynamic than the scheme the Commission envisions. Most importantly, they can provide much more granular sharing in the geographic and frequency domain, and can be augmented using the time domain.

For example, as Starry originally suggested in the record in this docket and has consistently reiterated,³² a spectrum sensing and beaconing mechanism could allow for far more flexible access and deployment in the Band, without the need for large geographic protection zones. Sensing and beaconing technologies can be used to facilitate sharing in three dimensions, using geography, frequency, and time through a syncing signal that is heard and used by disparate systems and technologies.

In addition, existing database tools can be enhanced and modified to operate in this Band. These databases can use more predictable geographic and frequency information than sensing-based sharing. They can use the existing information regarding base stations that will be publicly available, and could make very reasonable assumptions about CPE characteristics based upon a technical analysis of the deployment models in the Band. In addition, they can offer a level of control to users that may not exist in a fully distributed sensing-based sharing environment. And, if properly synced across systems, a database could also enable time-based sharing by serving as a central clock for synchronization, again leveraging GPS time.

Ultimately, these or other tools can be added to the coordination process over time to continue to enhance access to spectrum in this Band. We do not suggest that the Commission upend whatever licensing and coordination rules that they put in place in the short-term, but layer on more dynamic aspects over time. For instance, the sensing or database coordination could be

³² See Comments of Starry, Inc., GN Docket No. 14-177 *et al.* (filed Sept. 27, 2016); Starry Sharing Framework Proposal.

based on certain obligations to protect those systems that have already deployed. The Commission can stimulate investment in the Band now while continuing to iterate on the sharing rules by setting the expectation that the rules will continue to evolve but, to the greatest extent possible, existing licensed or registered sites will continue to generally receive the same protection.

III. THE COMMISSION SHOULD STRONGLY INCENTIVIZE NEAR-TERM USE OF THE BAND AND STRONGLY DISINCENTIVIZE SQUATTING AND ANTICOMPETITIVE FORECLOSURE

The Lower 37 GHz Band represents a prime opportunity for new entrants and other users to access useful licensed mmW spectrum with very low barriers. Like other coordinated bands, there is a non-zero probability that some users may act in bad faith and use the low barrier as a tool to foreclose other operators from accessing the Band in a specific area, or otherwise squat on the spectrum. The Commission recognizes this in its proposal for a penalty for non-construction.³³ We strongly suggest that the Commission both incentivize the use of the Band in the near term as part of its overall 5G strategy, and strongly discourage and penalize bad actors, including those who would foreclose legitimate operators' use for anticompetitive or other reasons. Below we suggest three steps the Commission can take to achieve these goals by minimizing foreclosure at the opening of the licensing window, requiring construction shortly after a license is granted (or a site registered), and prohibiting licensees from reapplying for the same license area for at least a year if they do not construct and disqualifying repeat offenders.

A. All Applications Filed at the Opening of the Application Window Should be Treated as Filed Concurrently

Considering the cadence of the licensing process, we believe that there is a risk that parties act in bad faith at the opening of the application window by trying to game the Commission's usual first-in-time licensing and coordination process. Generally, applicants in coordinated bands are treated in the order that they are received, functionally or explicitly creating first-in-time rights.³⁴ We agree with this general principle, but it could have a very inequitable outcome when applied to the immediate opening of the application window for the Band.

³³ *Third Frontiers R&O and FNPRM* at ¶¶ 71, 73.

³⁴ *See, e.g.*, 47 C.F.R. § 101.147(z) ("Site-by-site registration is on a first-come, first-served basis.").

For instance, if the Commission launches the Band by opening the window for new applications after midnight on Day 1, a party could write a software script to automatically file an anti-competitive number of applications within milliseconds of the window opening, thereby foreclosing all other applicants from using the Band in an area, or in the worst case, across the country. An applicant may do this for simple rent seeking – it would effectively acquire a massive footprint of valuable mmW spectrum that it might seek to monetize rather than use, thereby creating a new economic barrier to the Band. Or more nefariously, a party may do this to explicitly foreclose a competitor from gaining access to this highly-useful spectrum in a particular geographic area.

Instead, we suggest that the Commission establish a 24-hour opening window once the rules are finalized and it begins accepting applications for licenses in this Band. Specifically, any application filed within the 24-hour period from midnight Day 1 to midnight Day 2 will be treated as filed concurrently for licensing and coordination purposes. This will discourage parties from trying to front run the application processing at the outset, and allow parties with immediate needs for the Band to file applications for spectrum that they intend to use in the near term.

B. Base Station Licensees or Registrants Should be Required to Construct their Sites within 90 or 120 days of the License Grant or Registration

Construction requirements are the strongest tools in the Commission’s toolbox to encourage a licensee to use the spectrum to which it has been granted a use right.³⁵ Here, the Commission proposes that Base Station Licensees should have 18 months to construct a site and file the requisite construction notification.³⁶ For Site Cluster Licenses, the Commission suggests that the licensee would have two construction deadlines, the first to perfect the Site Cluster License, and the second to perfect any base station or point-to-point link registered within the Site Cluster protection zone.³⁷ We believe that under these schemes the Commission should require construction in all instances within 90 or 120 days of the grant of the license or registration.³⁸

³⁵ See *Frontiers First R&O and FNPRM*, 31 FCC Rcd at 8084-86 ¶¶ 191-92, 96.

³⁶ *Frontiers Third R&O and FNPRM* at ¶ 71.

³⁷ *Id.* at ¶ 73.

³⁸ In more dynamic sharing environments, the Commissions could ultimately rely on intelligence and reporting from the devices deployed in order to free up available and unused spectrum

With respect to Base Station Licenses, by the time a licensee files a license application, they will necessarily have identified the site on which the licensee intends to construct its base station, given the need to include the coordinates in the application. A licensee will also have had to procure the equipment (or be in the process of doing so) given the need to identify the equipment in the application. Therefore, when a licensee files an application, it should be fully prepared to construct a site.

Further, the Commission and Congress have worked aggressively to streamline small cell siting timelines down to 60 days in most cases,³⁹ and given the small componentry of mmW equipment it is likely expect most if not all 37 GHz base stations will qualify for this streamlined treatment.⁴⁰ If a state or local zoning authority takes longer than 60 days to process an application, the licensee could always seek a construction extension, as licensees frequently do for reasons outside of their own control. The Commission should use this existing tool to solve those edge cases where zoning approval takes longer than anticipated rather than structuring the requirement itself around an outlier event.

Finally, assuming the Commission uses a stock Part 101 coordination process, the construction timeline really begins sometime between the applicant sending its coordination notification and filing its license application. Somewhere in this period, a forward-looking applicant can begin the process of constructing the site, so that it is ready to operate the day that it files the application (on a temporary basis, as suggested below) or the day the license is granted. In combination, the timeline from a licensee sending a coordination notification and receiving a license is at best 45 days, and can be several months depending on the success of coordination and Universal Licensing System processing timelines. This will add weeks and in some cases months to the time within which a licensee must construct a site.

As a practical matter, if an applicant is planning a larger deployment across a market, it will be at a competitive disadvantage if it waits an entire 18-month period from licensing to operation. And financially, all but the largest operators will have significant financial pressure to begin to generate a return on capital. If the operator is equity financing the deployment, investors will want the operator to maximize subscriber growth over the shortest period of time. If the

³⁹ Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. 112-96, H.R. 3630, 126 Stat. 156, § 6409 (enacted Feb. 22, 2012); *Acceleration of Broadband Deployment by Improving Wireless Facilities Siting Policies*, Report and Order, 29 FCC Rcd 12865 (2014); *2018 Wireless Facility Second R&O*.

⁴⁰ Starry's largest base station is just over 2 cubic feet, for example.

operator is debt financing the deployment, it will need to begin to service the debt well before 18 months. And if the operator is self-financing a deployment, its ability to continue to expand and invest in its own network will be directly tied to the speed with which it can generate revenue on that investment.

An aggressive construction deadline will also strongly discourage speculative licensing. This Band – and all other coordinated bands – are designed to be purely utilitarian. That is, they are intended to make spectrum available to those who need it, where and when they need it. They are not intended to create a process for third parties to try to monetize the spectrum or to foreclose other users from accessing the Band by creating artificial contention.

We believe that the construction requirement could, in most circumstances be met in just 90 days from the license grant, and will best ensure that the spectrum and geographic area for which protection has been granted will be put to use expeditiously, to the public's benefit. In the worldwide race to capture the benefits of 5G, we believe that this requirement can help propel the Commission's goals forward. And at a maximum, as we previously suggested, 120 days is more than enough time for a licensee to construct a site for this Band.

We also suggest that the licensee must demonstrate that it is using the license to serve at least two end points within its protection zone, and must reference the service that it is providing (if commercial). Furthermore, we suggest that the Commission require a measure of the quality of the service to ensure that the provider is not simply constructing license savers. As we previously suggested, commercial licensees should have to demonstrate that they are providing service capable of a minimum speed of 100 megabits per second, with a minimum spectral efficiency of the transmitter of 4 bits/Hz.⁴¹ This minimum service requirement could easily be met by any fixed or mobile provider serving any use case given the power and bandwidth available in this Band.

A licensee could provide this information either to a third-party coordinator or the Commission. If the Commission prefers third-party coordinators to receive and retain this information, the third-party coordinators must be required to make this information publicly available at no charge in an easily accessible, searchable, and downloadable format. We suggest that the Commission spot-check the construction notifications against any commercial licensees'

⁴¹ Starry Sharing Framework Proposal at 5.

most recent Form 477 filings as a means of independently validating whether the licensee does in fact provide service in the licensed area.

With respect to Site Cluster Licenses, we agree that the Commission should impose construction requirements on both layers – the site cluster itself and any registered site within it. As with Base Station Licenses, we suggest that the Commission use a robust and aggressive construction deadline. We appreciate the Commission’s intent in proposing Site Cluster Licenses as a way to provide licensees some amount of predictability to access spectrum in a specific geographic area while it develops its plans for building out that area. But that does not mean that the licensee should have a significant amount of time to sit on that right without constructing a single site within the area. Therefore, we suggest that the Commission require Site Cluster Licensees to construct at least one registered base station within 180 days of licensing.

The existence of a Site Cluster License in an area may unreasonably disincentivize a potential applicant from applying for a Base Station License in that area, given that the Site Cluster License at a minimum identifies an area within which that licensee intends to intensively deploy. Therefore, it may have a larger than necessary precluding effect, and should not be used as a tool to disincentivize new Base Station Licenses within the area for extended periods of time without any use.

With reasonable but aggressive construction deadlines, the Commission can ensure that this spectrum is effectively put to use to the benefit of consumers across the country as quickly as possible.

C. Licensees Should be Prohibited from Filing for the Same Area if They Do Not Construct, and Repeat Offenders should be Permanently Disqualified

We strongly agree with the Commission’s proposal that any licensee or registrant that does not construct a site within the required timeline should be prohibited from seeking a license for any part of that geographic area that was previously part of its protection zone for at least 12 months. The Commission must send a strong signal to potential bad actors at the outset that there will be penalties for violating the Commission’s rules.

The Commission can further disincentivize bad actors by setting a threshold number of violations, which, once met, will automatically disqualify the applicant (and any applicant under the same control) from applying for any licenses in the Lower 37 GHz Band in the future. If an applicant’s goal is simply to disrupt legitimate users of the Band, they will not be deterred by losing a license or the ability to apply for a same site in the same location. The Commission can

determine now, in advance, what the threshold would be for a presumed determination that an applicant is not fit to hold a license in this Band as function of their demonstrated disinterest in constructing any site.

IV. THE PART 101 COORDINATION PROCESS SHOULD BE MODERNIZED TO EXPEDITE ACCESS TO THE LOWER 37 GHZ BAND

As discussed, we encourage the Commission to enhance the Part 101-based coordination process over time by adding dynamic coordination elements, including the use of dynamic databases (which could streamline or eliminate much of the Part 101 process), sensing (which could obviate the need for Part 101 in this Band entirely), or other tools. In the near term, we encourage the Commission to take small steps to improve and expedite the Part 101 process for the Lower 37 GHz Band, including by requiring electronic coordination notification and response, shortening the coordination timeline to ten business days, and allowing applicants to begin operations once their license application or registration is filed.

As an initial matter, we ask that the Commission make clear that Site Cluster Licensees that add base stations to their Site Cluster Licenses are simply required to add the registration to their license after the coordination process is complete. In other words, unlike other license applications, because the Commission will have already deemed it in the public interest to grant the applicant a license (the underlying Site Cluster License), the new base station registration should not have to go on public notice and should not require any Commission action in order to become effective. Base station registrations under Site Cluster licenses should be effective upon the date that coordination is successfully complete.

Because the coordination is simply based upon a factual determination of whether a radius has been accurately drawn from a single point, and whether that radius will intersect with another licensee's protection zone, a licensee should need no more than 10 business days to respond. This is a simple propagation and mapping exercise that takes minutes to complete. Allowing 10 business days in this case is generous, but will allow licensees to batch process coordination requests to the extent they receive multiples within the same time frame.

Finally, like many other mmW bands, we urge the Commission to allow an applicant to begin temporary operation upon the successful filing of its license application.⁴² This will allow a licensee to activate the spectrum immediately without delay for Commission licensing

⁴² 47 C.F.R. § 101.31.

processes. Of course, as with other bands, the licensee would do so with the direct knowledge and understanding that it is operating on a temporary basis, and for a variety of reasons, the Commission may ultimately deny its application and it will have to cease operation.

Combined, these streamlined processes will, at least in the near-term, reduce the unnecessary process delays associated with current Part 101 coordination, and facilitate rapid access to the Band.

V. CO-PRIMARY FEDERAL ACCESS CAN BE ACHIEVED THROUGH SIMPLE COORDINATION IN THE NEAR TERM AND MORE EXTENSIVE FEDERAL / NON-FEDERAL COLLABORATION

As the Commission recognizes, the Lower 37 GHz Band is an important co-primary band in which federal users share in the same rights as non-federal users.⁴³ We continue to believe that this Band is an opportunity to further enhance federal-commercial sharing, and that the Commission can facilitate more robust and flexible access, drive scale in multi-purpose equipment, and create a model for federal-commercial sharing in other bands in the future. We strongly support the Commission's intention to work in partnership with NTIA, Department of Defense (DoD), and other federal agencies to develop a sharing approach that allows for robust federal and non-federal use in this Band.⁴⁴

We suggest the Commission approach federal coordination with two goals in mind: 1) providing a predictable process in the near-term for both commercial and federal access; and 2) creating a predictable process for the future to facilitate continued federal access in parts of the Band that might be otherwise congested.

At the outset, we observe that as a function of physics, a federal and non-federal system cannot be located at the same geographic location, transmitting on the same frequency at precisely the same time. That means that there will necessarily be instances where a federal user has a protected right against a non-federal user, and vice versa. However, one of the benefits of mmW spectrum is that it is also, as a function of physics, highly shareable. The Commission, NTIA, DoD, and other federal agencies just need to determine how best to toggle geographic, frequency, and time-based protections to meet federal users' needs within this context.

⁴³ *Frontiers Third R&O and FNPRM* at ¶¶ 40, 62, 66. *Frontiers First R&O and FNPRM*, 31 FCC Rcd at 8056, 8170-71 ¶¶ 102, 446-49.

⁴⁴ *Frontiers Third R&O and FNPRM* at ¶¶ 40, 66.

In a perfectly optimized version of sharing, all systems could be coordinated through a synchronization system that facilitates micro-decisions about which device can transmit at which location, on which frequency, and at which time. Practically, it's unlikely that any commercial or federal user would want to vest that level of control over their operation with a third party (not to mention the cost and other barriers). So, this creates one bookend on the options for spectrum sharing, with the other being large geographic exclusion zones within which only one commercial or federal user may operate (*i.e.* geographically-licensed and auctioned spectrum / large exclusion zones around federal sites). Since neither of these are likely outcomes, we strongly urge the Commission, NTIA, DoD, and other agencies to explore the middle ground and the tools that exist within it, and select a combination of sharing techniques to effectively facilitate coordination in this Band.

For example, federal to commercial coordination could be achieved using geographic protection zones for both user sets, first in time coordination, and private coordination, all ultimately moving toward a more dynamic coordination and sharing regime that continues to add fidelity on the geography, frequency, and time dimensions on which federal and non-federal systems can share.

The Commission originally envisioned this Band as an optimal place to further enhance federal and non-federal sharing in part because of the parallel allocation on both sides of the Table of Allocations – fixed and mobile.⁴⁵ We understand the need for federal users to have flexibility in the types of systems that they may need to deploy in this Band, but for the purpose of developing a coordination methodology, it can become unwieldy to try to solve for every use case. Therefore, we suggest two features for federal and non-federal sharing.

First, we suggest that federal users, specifically DoD, should have presumed registered sites for a set of military bases outside of population centers. This would effectively increase the protected DoD sites from the 14 already protected from the start.⁴⁶ DoD could potentially also add additional sites (in this Band and in the full 37 GHz band) in more populated areas by coordinating directly with any licensee in the Band based upon a process set by the Commission and NTIA. Within the bases, we suggest that the FCC, NTIA, and DoD study the interference potential of airborne systems operating within the base to systems outside of the base in order to

⁴⁵ See *Frontiers First R&O and FNPRM*, 31 FCC Rcd at 8059 ¶ 111.

⁴⁶ 47 C.F.R. § 30.205.

determine the coordination methodology and protection criteria.⁴⁷ Starry's suggested protection criteria of -79 dBm/100 MHz is a good data point for beginning the analysis – its far from over protective, and is the same level of protection that we are suggesting among co-primary non-federal users. And we suggest that NTIA, in coordination with DoD, establish a baseline protection criteria that can be used if a commercial operator seeks to coordinate into a base. In all cases, coordination and protection criteria should be based on real-world assumptions, not worse case scenarios.

Second, outside of military bases (the 14 plus additional ones outside of populated areas), all federal users could coordinate fixed and mobile systems into the Band on the exact same basis as non-federal users. They could register base stations under the same coordination methodology, relying on NTIA to conduct their coordination. Alternatively, if federal users would desire a greater amount of flexibility in the protection criteria, the FCC could work with NTIA to determine a parallel basis for coordinating federal sites in the Band. We would also encourage NTIA to create a streamlined process for allowing federal sites in this Band, particularly if the federal user proposes to use commercial off-the-shelf technology or purpose-built technology with the same or similar characteristics (*i.e.* would comply with Part 30 technical rules if it were commercial equipment). And, as commercial coordination becomes much more dynamic, we hope that federal coordination can too, which will significantly reduce the administrative burden on NTIA and federal agencies.

Finally, the Commission should specify *in its rules* that federal and non-federal users are required to coordinate with each other in good faith. Ultimately sharing is best achieved when the parties involved trust that the other parties are acting in good faith.

VI. THE COMMISSION SHOULD CONTINUE TO EXPLORE ADDITIONAL MILLIMETER WAVE BANDS, AND SHOULD UTILIZE SIMILAR SHARING TECHNIQUES TO UNLOCK VALUABLE SPECTRUM

We support the Commission's proposal to open the 26 GHz and 51 GHz band for flexible fixed and mobile services. These bands offer an opportunity to continue to increase the availability of mmW spectrum for flexible use services, and we are confident that the Commission, federal agencies, incumbents, and industry can work collaboratively to solve the sharing issues that each present.

⁴⁷ See *Frontiers Third R&O and FNPRM* at ¶ 66 ("DoD has expressed an interest in a possible aeronautical allocation in the Lower 37 GHz band, so we anticipate including aeronautical cases in our consideration of coordination methodologies.").

We also encourage the Commission to keep open the possibility that these bands, or parts of them, may be unlocked for flexible use services through sharing techniques instead of just large geographic area exclusive licensing. In the race to 5G, putting capacity into the marketplace is critical. The Commission should not view the ability to use these band for flexible use services as binary – *i.e.* either they can be made available in large blocks at auction, or not. Ultimately, the sharing framework proposed herein can serve to unlock valuable spectrum in bands in which sharing might be required, preferred, or optimal, and we encourage the Commission to consider its use as another tool to meet its spectrum policy and 5G goals.

VII. CONCLUSION

The Commission has an opportunity to further energize its efforts to lead the world in 5G by quickly finalizing the sharing rules for the Lower 37 GHz Band to enable near-term access for innovative technologies and users. At the same time, it can further enhance competition in fixed and mobile broadband by creating a clear path to spectrum for all potential users. And it can continue to work with NTIA and federal agencies to further improve sharing techniques in this Band and elsewhere. We strongly and respectfully recommend the Commission take the steps described herein to unlock the value and potential of the Lower 37 GHz Band in the near-term.

Respectfully submitted,
Starry, Inc.



By: _____
Virginia Lam Abrams
Senior Vice President, Communications &
Government Relations

Starry, Inc.
38 Chauncy Street, 2nd Floor
Boston, Massachusetts 02111

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APPENDIX A

Sample Propagation/Link Analysis Using the NYUSIM Model⁴⁸

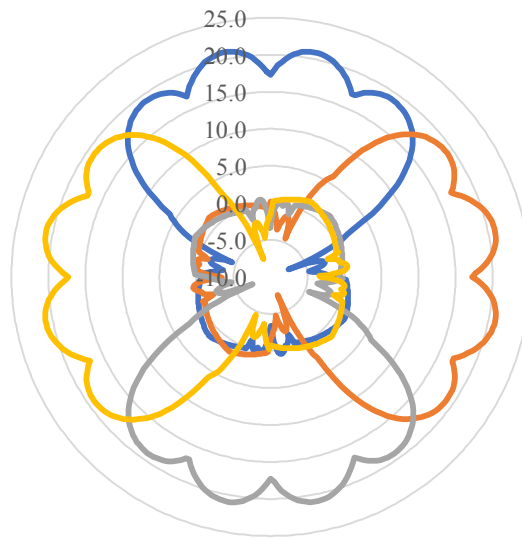
Variable	NLOS (exp = 3.4)	LOS (exp = 2.0)
EIRP	60 dBm	53 dBm
Gr	25	34
Noise Power	-114 dBm/MHz	-114 dBm/MHz
Noise Figure	5	5
Bandwidth (dB-MHz)	20	20
C/N	20	20
System Gain	145	153
Free Space Loss @ 1m (dB)	-63.9	-63.9
Free Space Link Margin (dB)	N/A	16.9
Received Signal Level (LOS) (dBm)	N/A	-42.9
SNR (LOS) (dB)	N/A	47
NLOS Loss (dB)	34.5	N/A
Received Signal Level (NLOS) (dB)	-59.4	N/A
SNR NLOS (dB)	-30.4	N/A
CPE Distance (m)	200	2000
Maximum Protection Zone Radius using -79 dBm/100 MHz (meters)	175	3000 (at +55 dBm EIRP)

⁴⁸ <http://wireless.engineering.nyu.edu/nyusim/>.

APPENDIX B

Notional Protection Zone in a 360 Degree Sector

Four 90 Degree Sector Antenna Combined Azimuth Pattern



Four 90 Degree Sector Antenna Combined Azimuth Pattern
with Protection Zone

